Claims

5   1.   A device (1) for routing data units in a network (3),
           comprising

           a receiver (10) for receiving data units from said
           network,

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           a buffer (111) for buffering data units received by said
           receiver,

           an output unit (12) for outputting buffered data units
15   to said network on the basis of routing information
           contained in said data units,

           a congestion monitor (110) for monitoring whether said
           device fulfils a predetermined congestion condition,

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           a congestion notification unit (110) for setting
           congestion notification information in one or more data
           units output by said output unit, if said congestion
           monitor determines that said congestion condition is
25   fulfilled,

           characterized by

           a congestion cause identifying unit (110) capable of
30   distinguishing between at least two different congestion
           causes, for identifying one or more causes of said
           congestion monitor detecting that said congestion
           condition is fulfilled, and

35   said congestion notification unit being arranged for
           setting congestion cause information based on the one or
           more causes identified by said congestion cause

identifying unit in said one or more data units in which congestion notification information is set.

2. A device according to claim 1, wherein said congestion monitor is arranged to monitor the degree of utilization of one or more resources of said device, and to determine that the congestion condition is fulfilled if the degree of utilization of at least one of said one or more resources fulfils a predetermined condition.

3. A device according to claim 2, wherein said predetermined condition is the exceeding of a predetermined threshold.

4. A device according to one of claims 1 to 3, wherein said congestion cause identifying unit is arranged to observe the degree of utilization of two or more resources of said device, and to identify said one or more causes on the basis of the observed degrees of utilization.

5. A device according to one of claims 2 to 4, wherein said resources comprise a buffering capacity and a data unit processing capacity.

6. A device according to claim 4 or 5, wherein said resources are grouped into one or more first resources and one or more second resources, and said congestion cause identifying unit is arranged to identify a first cause on the basis of the degree of utilization of said first resources and a second cause on the basis of the degree of utilization of said second resources.

7. A device according to claim 6, wherein said first resources comprise one or both of
- a buffering capacity associated with said receiver for buffering data units upon receipt by said receiver, and

- a processing capacity for controlling a transfer of
data units from said receiver to said output unit,
and said second resources comprise one or both of
- a buffering capacity associated with said output unit
for buffering data units to be output, and
- a processing capacity for controlling the output of
data units from said output unit.

8. A method of controlling a device for routing data units
in a network, comprising

receiving data units from said network,

buffering data units received by said receiver,

outputting buffered data units to said network on the
basis of routing information contained in said data
units,

monitoring whether a predetermined congestion condition
is fulfilled,

setting congestion notification information in one or
more output data units if said congestion condition is
fulfilled,

characterized by

identifying (S22) one or more causes of said congestion
condition being fulfilled, and

setting (S23) congestion cause information based on the
one or more identified causes in said one or more data
units in which congestion notification information is
set.

9. A method according to claim 8, wherein the degree of utilization of one or more resources of said device is monitored, and it is determined that the congestion condition is fulfilled if the degree of utilization of at least one of said one or more resources fulfils a predetermined condition.

10. A method according to claim 9, wherein said predetermined condition is the exceeding of a predetermined threshold.

11. A method according to one of claims 8 to 10, wherein the degree of utilization of two or more resources of said device is observed, and said one or more causes are identified on the basis of the observed degrees of utilization.

12. A method according to one of claims 9 to 11, wherein said resources comprise a buffering capacity and a data unit processing capacity.

13. A method according to claim 11 or 12, wherein said resources are grouped into one or more first resources and one or more second resources, and a first cause is identified on the basis of the degree of utilization of said first resources and a second cause is identified on the basis of the degree of utilization of said second resources.

14. A method according to claim 13, wherein said first resources comprise one or both of
 - a buffering capacity associated with said receiver for buffering data units upon receipt by said receiver, and
 - a processing capacity for controlling a transfer of data units from said receiver to said output unit,
and said second resources comprise one or both of

- a buffering capacity associated with said output unit for buffering data units to be output, and
- a processing capacity for controlling the output of data units from said output unit.

15. A computer program for executing the method of one of claims 8 to 14 when run on a device for routing data units in a network.

16. A data carrier storing the computer program of claim 15.

17. A communication device (31) for sending data units to a receiving communication device (32) over a network (3), said communication device for sending being arranged to receive from said receiving data communication device acknowledgment messages that contain receipt information regarding the receipt of sent data units and congestion notification information regarding congestion in the network, said communication device for sending being arranged to respond to said acknowledgment messages by adapting an operation of controlling the sending of data units in accordance with the information contained in said acknowledgment messages,

characterized in that

said communication device for sending is arranged to extract congestion cause information contained in said acknowledgment messages, and to adapt the operation of controlling the sending of data units in accordance with said congestion cause information.

18. A device according to claim 17, wherein the congestion cause information is designed such that the congestion cause information in an acknowledgment message can indicate the presence or absence of n different causes of congestion, such that each acknowledgment message

containing congestion cause information contains one of 2^n different combinations of congestion causes, n being an integer, and said communication device for sending is arranged to identify the congestion cause combination contained in an acknowledgment message and to invoke a response procedure corresponding to the identified congestion cause combination.

19. A device according to claim 17 or 18, wherein said communication device for sending is arranged to extract at least a first and a second congestion cause information, said first congestion cause information being associated with congestion due to the incapacity to handle the number of data units being transported, and said second congestion cause information being associated with congestion due to the incapacity to handle the amount of data being transported, and said communication device for sending is arranged to respond to the extraction of said first congestion cause information by reducing the number of data units output per unit of time, and to respond to the extraction of said second congestion cause information by reducing the amount of data output per unit of time.

20. A method for controlling a sending communication device that is sending data units to a receiving communication device over a network, comprising:
receiving from said receiving communication device acknowledgment messages that contain receipt information regarding the receipt of sent data units and congestion notification information regarding congestion in the network,
responding to said acknowledgment messages by adapting an operation of controlling the sending of data units in accordance with the information contained in said acknowledgment messages,

characterized by

extracting (S62) congestion cause information contained
in said acknowledgment messages at said sending
5   communication device, and
        adapting (S63) the operation of controlling the sending
        of data units in accordance with said extracted
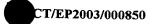   congestion cause information.

10   21. A method according to claim 20, wherein the congestion
          cause information is designed such that the congestion
          cause information in an acknowledgment message can
          indicate the presence or absence of n different causes
          of congestion, such that each acknowledgment message
15   containing congestion cause information contains one of
          2^n different combinations of congestion causes, n being
          an integer, and said method further comprising:
          identifying the congestion cause combination contained
          in an acknowledgment message and
20   invoking a response procedure corresponding to the
          identified congestion cause combination.

     22. A method according to claim 20 or 21, wherein said
          sending communication device is arranged to extract at
25   least a first and a second congestion cause information,
          said first congestion cause information being associated
          with congestion due to the incapacity to handle the
          number of data units being transported, and said second
          congestion cause information being associated with
30   congestion due to the incapacity to handle the amount of
          data being transported, and said method further
          comprising:
          responding to the extraction of said first congestion
          cause information by reducing the number of data units
35   output per unit of time, and

responding to the extraction of said second congestion
cause information by reducing the amount of data output
per unit of time.

5   23.   A computer program for executing the method of one of
claims 20 to 22 when run on a device for sending data
units over a network.

     24.   A data carrier storing the computer program of claim 23.

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     25.   A method of sending data units over a network (3),
comprising:

        sending data units into said network out of a sending
15   communication device (31) connected to said network,

        forwarding said data units in one or more routing
devices (33-44) of said network to a receiving
communication device (32) connected to said network,
20   each routing device buffering data units received from
said network, outputting buffered data units to said
network on the basis of routing information contained in
said data units, monitoring whether a predetermined
congestion condition is fulfilled, setting congestion
25   notification information in one or more output data
units if said congestion condition is fulfilled,
identifying one or more causes of said congestion
condition being fulfilled, and setting congestion cause
information based on the one or more identified causes
30   in said one or more data units in which congestion
notification information is set,

        receiving said forwarded data units at said receiving
communication device, said receiving communication
35   device sending acknowledgment messages into said
network, said acknowledgment messages containing receipt
information regarding the receipt of said forwarded data

units as well as congestion notification information and
congestion cause information set by said one or more
routers in said forwarded data units,

5   forwarding said acknowledgment messages through said
network to said sending communication device,

receiving said acknowledgment messages at said sending
communication device and responding to said
10   acknowledgment messages by adapting an operation of
controlling the sending of data units in accordance with
the information contained in said acknowledgment
messages, extracting said congestion cause information
contained in said acknowledgment messages at said
15   sending communication device, and adapting the operation
of controlling the sending of data units in accordance
with said extracted congestion cause information.